State of the Art Review (WP2)

Higher education institutions/Universities Responses to Digitalization (IO1)

Romania Country Report

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List of Abbreviations

ANC	National Authority for Qualifications
ANCOM	National Authority for Management and Regulation in Communications
ARACIS	The Romanian Higher Education Quality Assurance Agency
ARNIEC	Agency for Administration of the National Network for Education and Research
DESI	Digital Economy Society Index
DT	Digital Transformation
EPALE	Electronic Platform for Adult Learning in Europe
EQF	European Qualification Framework
ESCALATE	Coordinated Higher Institutions Responses to Digitalisation, Erasmus+ KA2 - Cooperation for innovation and the exchange of good practices, KA203 - Strategic Partnerships for higher education
ESCO	European Skills and Competence portal
EU	European Union
ICT	Information and Communications Technology
IO	Intellectual Output
ISCED	International Standard Classification of Education
KA	Key Action
MEC	Romanian Ministry of Education and Research
MOOCs	Massive Open Online Courses
PC	Partner Country
R&D	Research and Development
REI	Integrated Educational Register
RISC	Research Institute for Symbolic Computation, Linz, Austria
RMU	National Student Enrolment Single Registry
RMU	The Unique Matriculation Register
SIIIR	The Integrated Informatic Education System of Romania
SME	Small and Medium-sized Enterprise
SOTA	State-of-the-Art
UVT	West University of Timisoara
WP	Work Package

1   Introduction

Romania is being placed on the 26th position out of 28 European Union (EU) Member States (MS) within the Digital Economy and Society Index (DESI) for 2020 (European Commission, DESI 2020). Romania's performance was identical in four out of five dimensions measured by DESI, broadband connectivity being the only coordinate where Romania has very good achievements. Romania's digitalization progress has fallen way behind since almost one fifth of the Romanian people have never used the Internet, while a very small share (the lowest in the EU) have used the internet for interaction with public authorities (6 percent of people aged 16-74, 2017), same low performances being accounted in terms of using the internet to order goods or services for private use (18 percent of people aged 16-74, 2017).

Moreover, the share of people who never used a computer (percent of people aged 16-74, 2017) is the highest in EU.

Only 22 percent of companies use business software for sharing electronic information (compare to 34 percent EU average), 8 percent use social media, the similar per cent of companies issue electronic invoice, 5 percent use cloud computing (18 percent, EU average) and only 7 percent sell online (representing a turnover of only 4.3 percent).

On the other hand, however, Romania holds a good position as regards ICT graduates, being placed on the fifth position among the other EU countries (5.6 percent compared to the EU average of 3.6 percent of total graduates), yet if we consider the employed IT specialists the results are modest, namely 2.2 percent compared to an EU average of 3.9 percent. Higher education institutions (HEI) are a landmark in providing digital skills, being essential in bridging the educational offer with the labour market needs, tailored to professional profiles. The employment rate of recent graduates as a percentage of population aged 20-34 is relatively high in Romania, even though there are notable differences across regions.

At the same time, Romania registered notable achievements in terms of the educational background and labour market insertion of young people, still significantly behind the other EU, again with different performances from one region to another, as attested by the share of people neither in employment nor in education and training. However, the level of digital skills in the country is very low, Romania holding the second to last position among the EU, with no progress compared to the previous year. Same low achievements are registered in terms of 'at least basic' digital skills in the software area. Less than one third of the persons aged 16 to 74 have at least basic digital skills (compared to 58 percent overall the EU), while 35 percent have at least basic software skills (compared to an EU average of 68 percent). The situation is worst if we compare the 'above basic' digital skills, Romania registering only 10 percent, thus ranking last in the EU in 2020 and without any progress in the last two years.

The report is organized as follows. Section 2 contains methodological issues concerning the objectives and research questions. Section 3, 4,5,6, presents the results and their discussion. Section 4 contains several recommendations for action.

2 Methodology

This report is a state-of-the-art review study carried out in the context of ESCALATE project. The study aims to analyse how universities respond to digitalization with a special focus on impact (both on educators and students), problems associated with digitalization, and skills that are taught within mainstream education. Additionally, the identifying and reviewing of existing practices was also conducted.

The findings of this report were obtained through desk research and expert interviews.

The desk research consisted of searching and analysing data, reports and surveys about the impact of digitalization on higher education in Romania, contextualised according to the national labour market specificities. The data sources were selected taking into account their relevance, recentness (only reports and studies published in the last five years were selected) and reliability (sources that were totally unknown and sources with little information were omitted)

There were also analyses data sets from National Institute of Statistics, National Employment Agency and Ministry of Education. Reports and studies were searched on the web using specific keywords.

Expert interviews were employed, to explore in-depth some issues, and also for completing of those aspects that weren't covered in desk research.

The respondents were specialists familiar with the Romanian HEI. They were selected as they had connections with the process of teaching digital skills, using of digital technology for learning and teaching or having responsibilities in the area of educational policies and digitalization.

The respondents were selected based on their representativeness (different institutions/positions), geographical location (different areas of the country) and accessibility (previous collaborations).

The interviews were semi-structured containing open-ended questions to gather as many details as possible. The interviews have contained specific items which allowed the assessing of the potential impact of digitalization in expert interviewed organization and Romania, level of digital skills and skills needed to sustain digitalization, barriers to adopting digital technologies, identifying the current policy, both nationally and locally, and also the Higher Education Institution response to digitalization. The respondents were asked to indicate critical points and gaps in policy response, according to their own opinion, as well as to indicate good practices in their own organizations or anywhere else they know about and to make recommendations for action.

The triangulation of desk research and semi-structured interviews results allowed us to examine the characteristics of digitalization in Romania.

3   The potential impact of digitalization

Digital transformation is generating a fierce debate among education providers, policy-makers, economists and industry leaders about its societal impact. As digitalization disrupts society ever more profoundly, concern is growing about how it is affecting issues such as jobs, wages, inequality, health, resource efficiency and security. Current estimates of global job losses due to digitalization range as high as 2 billion by 2030 (World Economic Forum). There is currently great uncertainty, with concerns also about its impact on wages and working conditions.

According to PwC's Workforce Disruption Index (PwC, 2019), in the next ten years, the digital transformation generated by new technologies will affect 600,000 jobs in Romania. The report highlighted that about 325,000 new jobs will be created over the next decade, while another 275,000 workers will need to improve their digital skills, as automation and the introduction of artificial intelligence will gradually eliminate repetitive activities.

In this context, understanding the impact of digitalization and finding the appropriate responses is critical. Next sections entail several effects of digitalisation, connected to the Romanian socio-economic specificities.

3.1   Digital divide

Digital divide refers to the gap between those who benefit from digital technology and those who do not. As the access to the internet is neither universally available nor free, poverty is one of the main causes which impair access to an internet connection.

In 2018, 72.4 percent of the Romanian households had fixed internet connections. Almost half, 47 percent had high-speed connections that allowed download speeds of over 100 Mbps. However, there are important differences between urban and rural areas. For instance, according to the ANCOM[1], 75 percent of the households with fixed internet connections are in urban areas while, in rural areas, were only 49 percent. There are also geographic differences. In Bucharest region, 8 out of 9 households had internet connection. The capital region is followed by West and North-West regions, but the lowest levels are in the North-East region (65.1 percent) and in the South-East region (65.2 percent). These latter two regions also account for the lowest level of GDP per capita.

The Covid-19 pandemics emphasizes the digital divide. As many students were forced to take online lessons, the access to internet, having a PC, smartphone etc. limited equal access to education. A study

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[1] National Authority for Management and Regulation in Communications

employed (AgoraDigi, 2020) during the first stage of the pandemic showed revealed a huge impact particularly on children from families with social and economic problems.

Age is another variable which contribute to digital divide. Younger generations differ from older generations by technology. The Romanian population is strongly affected by the demographic ageing. Crude rate of total population change, per 1 000 persons was -5.0 in 2019, with a crude birth rate of 9.6 and a crude death rate of 13.4. The median age was 42.5 years. The age structure reflects the existence of demographic ageing phenomenon, which has determined the fall in the share of young population (0-14 years) and the absolute and relative increase in the share of older people (60 years and over). Proportion of population aged 0-14 years was 15.7 per cent in 2019, while the proportion of population aged 65 years and more was 18.5 per cent, resulting an age dependency ratio (population aged 0-14 and 65 and more to population aged 15-64) of 52.0 per cent. From the population with the age between 16 and 74, over two third of internet users (77.7 percent) have the age between 16 and 55 and only 22.3 percent have the age over 55.

Moreover, 81.8 percent of the user (82.4 percent in rural areas and 81.2 percent in urban areas) use the internet for participating in social networks (creating user profile posting messages or other contributions to Facebook, Twitter etc.); 63,3 percent (63.7 percent in rural areas and 69 percent in urban areas) use internet for making calls (including video calls), for example via Skype, Messenger, WhatsApp, Facetime, Viber etc., and 57.1 percent for sending emails (50.2 percent in rural areas and 64.1 percent in urban areas). On the other hand, only 10.3 percent (5.3 percent in rural areas and 15.4 percent in urban areas) use internet banking, 6.4 percent (6.1 percent in rural areas and 6.8 percent in urban areas) for looking for a job or sending a job application over the internet, and only 3.2 percent (2.4 percent in rural areas and 4.1 percent in urban areas) for selling of goods or services. As it can be noticed, in some cases differences between rural and urban areas are much higher.

Education is another variable which impair the access and use of the internet. The more educated a person is, the bigger opportunity they have to have an internet connection. For instance, 96.5 percent of households have internet connection if the head of household has a university level of education, 91.5 percent in case of upper-secondary education and only 55.5 percent for lower-secondary studies or 33.6 percent for primary studies.

In conclusion, the case of Romania is very relevant from the point of view of the existence of digital divide. The no access to the Internet increase not digital divide, but also a social divide.

3.2   Digital skills gaps

In 2009, the European Commission (EUR-Lex, 2009) indicated eight key competences which are important in the knowledge society and which should be constantly improve through lifelong learning strategies. These are:

- Communicating in a mother tongue: ability to express and interpret concepts, thoughts, feelings, facts and opinions both orally and in writing.
- Communicating in a foreign language: as above, but includes mediation skills (i.e. summarising, paraphrasing, interpreting or translating) and intercultural understanding.
- Mathematical, scientific and technological competence: sound mastery of numeracy, an understanding of the natural world and an ability to apply knowledge and technology to perceived human needs (such as medicine, transport or communication).
- Digital competence: confident and critical usage of information and communications technology for work, leisure and communication.
- Learning to learn: ability to effectively manage one's own learning, either individually or in groups.
- Social and civic competences: ability to participate effectively and constructively in one's social and working life and engage in active and democratic participation, especially in increasingly diverse societies.
- Sense of initiative and entrepreneurship: ability to turn ideas into action through creativity, innovation and risk taking as well as ability to plan and manage projects.
- Cultural awareness and expression: ability to appreciate the creative importance of ideas, experiences and emotions in a range of media such as music, literature and visual and performing arts.

Therefore, digital competence is one of the vital competences in the 21 Century. It involves the confident and critical use of Information Society Technology for work, leisure and communication. Digital competence is grounded on basic skills in ICT, i.e. the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet (Ilomäki, L., Kantosalo, A., & Lakkala, M., 2011).

Almost all EU countries developed specific national strategies related to digital competence. In Romania, the ability of using ICT is considered a key competency that should be provided by school and its importance is highlighted including by the Romanian National Education Law. A discipline in the field of ICT is compulsory starting with the lower secondary level (ISCED 2). Digital competences are further provided through the national curriculum at the upper secondary level (ISCED 3, grade 9-12). Actually, Romania has the highest amount of instruction time allocated for ICT as a compulsory separate subject in compulsory upper secondary education (168 hours) (European Commission/EACEA/Eurydice, 2019). At the ISCED 7-8 level, the digital competencies provided by universities are much more advanced.

Despite this, digital skills gap is widening and fast, with more and more recruiter claiming, for instance, that is difficult to find appropriate candidates. Even though the national curricula oblige educational provider to train digital skills, it seems that here is an important gap between what is provided by school and what is required by labour market. The experts interviewed reported difficulties in finding appropriate employees from the point of view of required digital skills. Additionally, the PwC Romania's Workforce Disruption Index claimed that about 275,000 Romanian employees should learn in the next decade new or superior digital skills (upskilling) to maintain or find jobs. Another research - PwC Central and Eastern Europe Private Business Survey 2019 (PwC Report, 2019) – found that about 18 percent of companies mention difficulties in hiring the digital experts.

Covid-19 pandemic has accelerated digitalisation and will force more and more employees to improve their digital skills. As this is not a simple process, it is expected, at least on a short time, the digital skills gap will be widening.

3.3   Future of work

Global job losses due to digitalization are estimated to 2 billion by 2030 (World Economic Forum, 2018), while the current covid-19 pandemic has outburst on the global economy making digitalization even more relevant and a key milestone to overcome these challenges. As Coibion, Gorodnicjenko and Weber (2020) underline, the preliminary indicators to assess the impact of Covid-19 on the global economy show dramatic declines in employment (20 million decrease in the number of workers), and a wave of early retirements with obvious negative effects on the economy.

Another particularly worrying aspect that the authors highlight is the fact that most of those who lost their jobs due to the Covid-19 outbreak are not looking for a new job. Also in Romania, because of inherent government public health strategies and social distancing measures to mitigate the spread of Covid-19, many businesses have dwindled the number of workers or even closed down all the activities, while other have reoriented their activities online, making digitalization even more relevant and decisively important for any economy.

These challenges are amplified for Romania in the digitalization framework, due to some of the lowest digitalization performances accounted by the country over the years.

Within the EU, the European Commission's Digital Economy Society Index for 2020 (European Commission, DESI 2020) shows that even though several EU countries have registered a notable progress (Ireland, Netherlands, Malta and Spain), the majority of the countries, which are below the EU average in the level of digitization, have not progressed significantly in the last five years. Hence, the EU Member States still face deep digital development gap, Romania being placed at the bottom of this ranking, along with Greece and Bulgaria. Mas and Pallais (2020) emphasized that "median worker reports that only 6

percent of their job could be feasibly done from home", compared with white collar workers from the IT sector or business and financial sector, who can easily work from home. Mongey and Weinberg (2020) prove that individuals who cannot work from home are more likely to be medium or low educated, non-white, lower-income and without employer-provided health insurance. The number of jobs that can be made from home, using digital instruments, will be an important indicator for the economy's performance (Dingel and Neiman, 2020).

Countries, which will be able to enhance and efficiently use the digital skills of the labor force, will win the economic battle in these times of social distancing.

3.3.1   Automation and robotisation

The literature abounds in descriptions of the impact of automation and robotisation in the Industry 4.0 era with focus on both, potential opportunities offered at the macro- / microeconomic level, and also the predictions about the future impact on the environment, socially and economically, especially on the labor market in general and at the level of specific jobs in particular.

The scenarios developed (e.g. WEF, Platform Industry 4.0, Hannover Mess, International Federation of Robotics) on how humanity will be affected globally by the 4th wave of industrialization, whose presence has just begun to be felt, oscillating from the most optimistic / utopian, with new jobs created, much more flexible and better paid, to the darkest / dystopian, with millions of jobs lost and people who will no longer be able to make a daily living, possibly with the introduction of a single income as a saving solution.

An increasingly polarized labor market is emerging between low-skilled / non-qualified workers and high-skilled workers, the first ones mentioned being in imminent danger of losing their jobs.

While some authors (Frey and Osborne, 2013) anticipate a future in which a substantial number of occupations are at risk of computerization and will be fully technologized, others (Arntz, Gregory and Zierahn, 2016), consider this as an overestimation and a wrong approach, saying that the risk of becoming technologized has a high impact only for some tasks related to an occupation, the rest of the tasks being still performed by people. Based on a task-centered approach, Arntz, Gregory and Zierahn estimate (for 21 OECD countries) an average of only 9 percent of automatable jobs, the percentage being in fact heterogeneous among the countries evaluated (e.g. 6 percent Korea and 12 percent Austria), the differences being due to the education, the way work is organized and / or the level of technology of the analyzed countries.

In Romania, the SME Robotization Barometer (Romania Journal, 2020) carried on in March 2020 for Universal Robots shows that about 28 percent of SMEs are planning to robotize their production in the next 3 years. Of these, 38.8 percent plan to implement collaborative robots and 58.6 percent industrial

robots. Respondents indicated that they are planning to robotize mainly assembly processes (57 percent), pick and place (55.9 percent), packaging and palletizing (47.7 percent), loading/unloading (46.5 percent).

The introducing of robots is considered by 100 percent of respondents as a way to increase quality of product, competitiveness and production volume (97.8 percent), reduce the lead time (92.7 percent), to lower production costs and therefore improve its efficiency (92.2 percent), eliminate human errors (91.4 percent), obtain the standardization of processes (90.5 percent), as well as increase production flexibility (88.8 percent) and work safety (88.5 percent).

On the other side, according to a survey employed by BestJobs in 2019 (Business Magazin, 2019), more than half of employees interviewed consider that their jobs are threatened by the emergence of robotisation and automation. Thus, about 12 percent of employees consider that the robots and automation will replace them in the next five years, 14.6 percent consider that this is a possibility in the next 5 to 10 years, 11.3 percent think their roles could be automated in 10-15 years, and 14 percent consider that it would take at least another 20 years for that to happen. However, 48 percent don't think that automation could ever fully take over their jobs.

The increasing role of robots push about half of the respondents to constantly develop multiple skills in order to be able to change their job if necessary. Another 41 percent states that they are in a continuum process of learning and training to increase their skills level and mitigate the risk of being replaced by robots. At the same time, only 17 percent of respondents do not do anything to develop their skills level.

The survey covered only employees from urban area who use internet regularly. Therefore, it should be taken into account that Romania is being placed on the 26th position out of 28 European Union (EU) Member States (MS) within the Digital Economy and Society Index (DESI) for 2020 (European Commission, DESI 2020) and only 75 percent of the households with fixed internet connections are in urban areas while, in rural areas, are only 49 percent.

In many studies, the Central and Eastern European countries are classified among those economies where jobs are at highest risk of being automated (Cséfalvay, Z, 2020). Automotive industry is the best example in this way. Though, the difference is still wide (only 42 robots per 10,000 employees in Romania compared to 1,046 in Belgium), the pace of robotization of this sector put at risk an important number of employees in Romania.

3.3.2   Autonomous and intelligent vehicles

The automotive industry account for 14 percent of Romanian GDP and represents about 26 percent of total exports. It is the biggest industry from Romania and the main driver of the economy. Specialists warns that this industry is threatened by the lack of labour force and an educational system capable to tackle with Industry 4.0 challenges (Forbes, 2018).

Emergence of autonomous intelligent vehicles will require more and more specialists with specific skills to sustain further development of this industry and also, adjacent industries and infrastructure necessaries for functioning of these vehicles.

Despite the importance of automotive industry in Romanian economy, the country is deficient in specialists in this field. Romania is ranked 17th in Europe in number of IT graduates, only 16/1000 inhabitants. Some data (HotNews.ro, 2020) show that there is a deficit between 15,000 and 30,000 IT specialists in Romania. This crisis is amplified by the Brain Drain migration (Panzaru and Reisz, 2017), about 43,000 IT specialists emigrated by now, according to Romanian Government.

Moreover, at the moment there are only a few higher education programs which provide targeted skills needed for the sector of autonomous and intelligent vehicles.

The autonomous vehicles will also lead to disappearing of other jobs such as: truck drivers, couriers and taxi drivers. For instance, in 2017 there were 150,000 truck drivers in Romania, the most numerous professional category, they being at risk due to emergence of the autonomous vehicles.

3.3.3   Digital nomadism

Digital nomads (Nash, C., Jarrahi, M. H., Sutherland, W., & Phillips, G., 2018) are people who use ICT technologies to earn a living and, more generally, conduct their life in a nomadic manner. Such workers often work remotely from foreign countries, coffee shops, public libraries, co-working spaces, or recreational vehicles. The phenomenon of digital nomadism is generated by the wish of travel combined with a wish for a better life.

Digital nomads create a work style which is totally different by the conventional types of work. They work in a digital environment, via Internet. Usually, they have individual arrangement within specific projects or manage their own business. Digital nomadism can be considered a form of (solo-)entrepreneurship or "electronic" freelancing (Aguinis, H., & Lawal, S. O., 2013; Laubacher, R. J., & Malone, T. W. ,1998). Freelance digital workers are able to source such work through online marketplaces.

At the moment, destinations such as Cyprus, Thailand, Bali (Wang, B., Schlagwein, D., Cecez-Kecmanovic, D., & Cahalane, M. C., 2018) or even UK (The Telegraph, 2015) are very popular. Recently, Romania,

particularly city of Timisoara, Cluj-Napoca and Bucharest became also very popular among digital nomads. The main reasons for choosing Romania as a destination are, on the one hand, the cost of living (Romania is cheaper than many European destinations) and, on the other hand the It infrastructure (e.g. Romania has some of the fastest internet speeds in the world). Therefore, in the cities mentioned before already rise several coworking spaces. For example, in Bucharest for only 5 euro by day it can be rented a place to connect and work.

The presence of digital nomads affects the local labour markets in many directions: new form of competition on labour market (including competition with local graduates), tax and labour obligations, housing market, working hours, type of contracts requested (e.g. increase the request of short-term contracts) etc.

3.4   Business models and innovation

The emergence of digitalisation change the business model of companies in Romania. A research (Valoria, 2017) assessing the perception of CEOs about the impact of digitalisation reveals the importance of this. For instance, about 35 percent of companies states that digitalization has already had a big influence on their business. However, only 31 percent consider that they have the appropriate knowledge to cope with this process. At the same time, 61 percent of companies say they have difficulties related to digital transformation. Of these, 39 percent have doubts they will be able to capitalise on this trend but only 2 percent say that they don't trust that digitization is good for the company.

The same research found that the companies from the IT sector and mass-media are the most heavily influenced by the digitalization, with about 80 percent of respondents agreeing with this. They are followed by 75 percent of those in financial-banking services. The industries less or not at all influenced by digitalization in Romania are construction, real estate, food, agriculture and transport. Surprisingly, the most companies from the utility and energy sector are confident in digitalisation but they consider that do not have appropriate knowledge to capitalise on this trend. On the other hand, most of the companies from the transportation sector are also confident in digitalisation and consider that they know how to capitalise on it.

The importance of digitalisation is also highlighted by the existence of a top management leader responsible by this process in most of the companies. For instance, 83 percent of companies in the sector of research and development have a designated manager responsible to digital development, 50 percent in the utility/energy sector, and pharmaceutical and health sector, and 44 percent in the trade sector.

On the other hand, 83 percent of the companies from construction and real estate sector, 72 percent of the companies from industry and production, and 57 percent of the companies from services sector (except financial sector) do not have a designated manager to deal with digitalisation process.

However, all companies state that expertise required for digitalisation of business is important and even they still do not have it, intend to invest in this direction.

The report also shows that the high-income firms are more interested in implementing digital solutions than small companies in order to strengthen their dominant position in the market. Small businesses are privileged because they either have a combination of organizational, human and technological factors that make them to already be a digital company as digital or have very little change to be done in their business model for digitalisation.

On the other hand, in terms of business models, 75 percent of companies with a turnover over 100 million Euro stated that new and digitally endowed business models have greatly changed the industry in which they operate. This is followed by a dramatic drop to 41 percent of companies with a turnover of between 50-100 Euro million and 36 percent of those with turnover of 10-50 million Euro. The majority of businesses within these three groups – with turnovers above 10 million Euro– do not believe that digital business models are a threat.

3.5   Civic engagement

Digital innovation changes the existing and enable new forms of civic engagement sometimes making the democracy more participative than ever. In Romania, statistics (National Institute of Statistics, 2019) shows that the young people are the most active category in terms of political and civic participation on the internet. About 14 percent of pupils and students have used the internet to express their civic or political view or to involve in different civic initiatives. They were followed by employees with about 13.7 percent, unemployment persons (12.7 percent) and pensioners (only 5.4 percent). In addition, it should be noticed the high participation of the youngers in elections, mobilization being mainly made through internet. Also, in some cases, demonstrations and street protests broke out due to digital mobilisation of people, particularly youngers, through social media platforms.

It is not surprisingly that the young people are very active on the internet taking into account the trend of migration from real to digital. Not only demographic patterns, but also urbanisation and technological advances are driving key changes in how citizens interact, mobilise and engage with decision-makers. For instance, about 75 percent of the households with fixed internet connections in Romania are in urban areas and only 49 percent in rural areas. About 74 percent of users are active on social media. At the same time, 63 percent use Internet to read news.

However, the offline engagement is still dominant in Romania, but with the increasing access to the internet and growing up of the digital natives it is expected that social media and online digital platforms will become the new public spaces for civic engagement.

4 Current policy and educational/universities responses

Digitalization is transforming the skills needed by Europe's working population to successfully engage in the world of work in a globalized modern economy. In this context, higher education institutions play a key role in providing the digital skills required by the labour market in the globalized modern economy. Consequently, national education systems must swiftly and appropriately respond to the challenges digitalization poses.

Education is seen today, more than ever, as a commodity worth investing in throughout life, being the central topic of debates of all political, economic and social factors concerned with facing the present and the future challenges (Rychen, D. S., 2003; OECD, 2012; OECD, 2013; OECD, 2017; European Commission, 2016).

For example, European Commission (2011) in "Supporting growth and jobs - An agenda for the modernization of Europe's higher education systems", states, among other topics, that: higher education enhances individual potential and should assure for the graduates the transferable competences and the knowledge they need to succeed in highly skilled occupations; curricula often slowly responds to the changing needs of the economy as a whole and fail to anticipate or help shaping the careers of tomorrow, while graduates struggle finding a quality job in line with their studies; the reform and modernization of Europe's higher education depends on the teachers' and researchers' competence and motivation.

However, it is reported that teaching and research staff have often not kept pace with the expansion of the number of students. The statement mentioned that better working conditions, including transparent and fair recruitment procedures, initial and continuous professional development, and better recognition and reward for excellence in teaching and research are essential to ensure that Europe produces, attracts and retains the high-quality academic staff it needs.

4.1 National Policy

The main document related to digitalization is the Digital Agenda for Romania 2020. Recently, in October 2020, the Romanian Ministry of Education launch a public debate for a digital strategy in education. A program of supporting digitalization of SMEs is also run by Romanian Government.

4.1.1 The National Strategy on Digital Agenda for Romania 2020

The National Strategy on Digital Agenda for Romania 2020 was adopted by Romanian Government in April 2015 (Romanian Government, 2020).

The Digital Agenda defines the major role that the use of information and communication technology (ICT) will have to play in meeting the Europe 2020 objectives.

National Strategy for the Digital Agenda sets out four areas of action as follows:

1. e-Government, Interoperability, Cyber Security, Cloud Computing and Social Media - field which aims to increase efficiency and reduce costs in the public sector in Romania by modernizing the administration;
2. ICT in education, culture and health - field which aims to support these technologies at the sectoral level;
3. ICT in e-commerce, and research, development and innovation in ICT - area aimed at regional comparative advantages of Romania, and backs growth in the private sector;
4. Broadband and digital infrastructure services - aimed at ensuring social inclusion field.

A full implementation of the strategic vision of the ICT sector in Romania will result in a total investment of around 2.4 billion euro. Direct and indirect impact on the economy can be translated into a GDP growth of 13 percent, increase in the number of jobs by 11 percent and cut in administration costs by 12 percent during 2014-2020.

Concrete measures set out in the Strategy will lead to:

- Ensuring access to electronic public services for citizens and organizations (e-government services);
- Improving access to the Internet by increasing the coverage of high-speed electronic broadband communications networks;
- Increased use of the Internet;
- E-commerce promotion;
- Increasing the number of cross-border electronic public services;

- Enhancing digital content and the development of ICT infrastructure in education, health and culture;
- Supporting the growth of the ICT sector added value by supporting research, development and innovation in the field.

The strategy also establishes the following indicators for 2020 Romania:

- At least 35 percent of people use e-government systems;
- At least 60 percent of citizens use the Internet regularly;
- At least 30 percent of citizens make purchases online;
- Coverage with broadband communication networks (over 30 Mbps) of minimum 80 percent.

National Strategy for the Digital Agenda defines the framework for an institutional structure that will provide a unified vision, will centrally and coordinately manage all aspects of computerization of public services and achieving interoperability at European level.

The Romanian Agency for Digitalisation, was set up in 2020 as a specialized entity responsible with the implementation of the Digital Agenda.

4.1.2   Strategy on the Digitalization of Education in Romania 2021-2027

Romania does not have a strategy on digitalization of education. At the moment, the framework of digitalization of education is ensured by the National Strategy on Digital Agenda 2020.

However, in October 2020, the Ministry of Education launched a process of public consultation to develop a national strategy on the digitalization of education Ministry of Education, 2020). Under the name SMART-Edu, the initiative is connected to The Digital Education Action Plan (2021-2027) of the European Commission (2020).

The main coordinates of the SMART-Edu are the following:

- To develop and enhance digital skills at every level of education cross-curriculum, through specialized training and disciplines, respectively formal and non-formal activities;
- To support initial and continuous (lifelong) digital training for educators/professors;
- To improve the digital infrastructure in order to lower the connectivity gaps (e.g. internet connections, configure internal networks, equipment supply, technical support);
- To support education institutions through incentives for educational offers with digital qualifications and degrees tailored to the professions of the future;
- To design digital education instruments and to encompass innovation in order to adopt new creative, interactive and student/pupil centered educational solutions;
- To create attractive open access educational resources;

- To develop and multiply public-private partnerships through the participation at digital networks, including ones with European and international bodies/institutions;
- To perform best-practices exchanges via local educational platforms, respectively e-learning national platforms and other international platforms (e.g. SELFIE, e-Twinning);
- To encourage and support initiatives for online security, cybernetic and data protection, IT ethics;
- To develop a framework of strategic forecasting for a green economy and to adapt to the professions of the future.

4.1.3   The National Program for the Digitization of SME

Recognising the importance of digitalization for economic development, the Romanian Government launched a program to sustain digitization of SME's and also development of SME's in the field of ITC. The funds are provided within the Competitiveness Operational Program 2014-2020. In the context of Covid-19 pandemic, about €550 million were redirected by the European Commission to support micro, small and medium-sized enterprises (SMEs) and to initiatives for digitalisation and e-education.

The funds are mainly allocated for projects in the field of IoT; smart city, village and agriculture; cyber security; big data; artificial intelligence, Blockchain, Virtual Reality (VR) and Augmented Reality (AR); electronic transactions; e-government, e-administration, e-health and e-education; industrial digitization (automation, robotization).

4.2   HEI response to digitalisation

Universities play a crucial role in equipping both educators/teachers and youth (learners) with the digital skills required in the new millennium (digital-age learning). To better understand the impact of digitalization on HEIs and the way in which these respond to it, we focused on the case of West University of Timisoara, one of the dynamic University from Romania in the field of digitalization.

4.2.1   Case study – West University of Timisoara

West University of Timisoara was founded in 1944. It is the fourth largest university in Romania and a regional leader in the field of higher education and research. The 11 faculties of WUT cover all the main

directions of study in the fields of science, economics, law, social and political sciences, humanities and arts.

West University of Timisoara is well known for its initiative in the digitalization area. In the last three years, the West University of Timisoara invested about 4.5 mil. Euro in IT infrastructure. Additionally, specific academic courses were developed.

4.2.1.1 New courses in the field of digitalisation

Apparently, Universities have high autonomy in Romania. Each university is free to decide everything from their management to the organization of classes. However, curriculum is developed in accordance with the framework provided by the ARACIS[2] and is based on compulsory and optional disciplines. From this point of view is not very easy for a University to develop a new course or a new academic program.

In the last years, West University of Timisoara set up various master programmes focused on providing digital skills (ISCED 7 level). They are listed below:

- *Artificial Intelligence and Distributed Computing* , it is a master program which provide theoretical and practical knowledge useful in modelling designing and implementing systems based on artificial intelligence methods and parallel and distributed approaches, performing cloud computing and high-performance computing; designing multi-agent systems; configuring machine learning, deep learning models, configuring network security models and architectures, modelling and Verifying Algorithms in Coq;

- *Big Data – Data Science, Analytics and Technologies* provides skills in the design of efficient and robust models for statistical analysis of data, design implementing and using data mining algorithms, in using technologies for big data processing and in implementing scalable applications, Big Data Technologies, Data Warehouses, Cloud Computing, Data Mining, Machine Learning, Data Analysis and Programming in R, designing and implementing Probabilistic Models for Data Science, Predictive Models and Analytics, Optimization, Biostatistics;

- *Information Systems for Businesses* provides advanced knowledge of business intelligence, MS SQL Server Business Intelligence, Oracle Business Intelligence Tools and Technology, IBM – Cognos BI, advanced capabilities on SAP Enterprise applications, modelling business processes, advanced methods and techniques for software engineering, web design, web programming, Enterprise reporting: SAP BEx, Crystal Reports, Web Intelligence, Design Studio, Lumira, Analysis for Office 2.2 report outputs in SAP BEx Query Designer, advanced methods and techniques to approach and investigate informatics systems (Agile, SCRUM, XP, DevOps, UP, MDA, MVC, ASAP), advanced use of supportive informatics applications to develop information systems (MS VISIO, MS

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[2] ARACIS is the Romanian Agency for Quality Assurance in Higher Education and has the main purpose to carry out the quality external evaluation of education provided by higher education institutions and by other organizations providing higher education study programs in Romania

WorkFlow, UI Path, Python, IBM INNOV8, IBM Websphere Business Modeller, ARIS, SAP Solution Manager), developing websites and online businesses, Web performance optimization;

- *Cyber Security* it is the newest master program set up at the WUT. It focused on developing architectures and models of network security, ensuring the quality and reliability of software systems, developing robust applications, processing large amount of data, developing multi-agent systems, data mining, applying methods and techniques based on XML, security and share of public interest data.

Additionally, postgraduate courses are occasionally developed at the West University of Timisoara, sometimes with the support of local or regional companies. This represent actually the most concrete response of University to the skills needs of the labour market. A list with the postgraduate courses organized at the West University of Timisoara is provided below:

- *Blockchain Entrepreneurship*: provide advanced capabilities and knowledge on cryptocurrencies programming and transactions, the blockchain technology, programming applications on various blockchain platforms, blockchain entreprenurship and financial skills;
- *Digital Skills in Services*, provides efficient use of computer systems, operating systems and the Internet by the employees from various organizations in the ICT sector, adequate use of office supplies software products to solve specific problems;
- *Technologies and Digital Resources for Online Training,* it is a program set up during the Covid-19 pandemic. It provides skills of efficient use of resources and digital instruments, communication and collaboration based on digital technologies, problem solving in terms of digital technology, G-suite for Education, Microsoft Teams for Education, (Learning Management System - LMS) Moodle.

4.2.1.2   Management and support services

In order to sustain the digital transformation within the West University of Timisoara, in 2020 it was set up a specialized Department on Digitalisation and Data Analysis (DTDA). The general objective of the DTDA is to ensure the current software's functionalities and also to develop a coherent architecture for a complete digital ecosystem in the University.

Department on Digitalisation and Data Analysis aims to:

- Optimization of the all workflows providing appropriate software tools;
- Coordination of the data collecting, analyses and providing reports[3] to Ministry of Education, National Institute of Statistics, National Authority for Qualifications[4] etc.;

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[3] According to the law, HEI must provide periodically data to Governmental Agencies.
[4] National Authority for Qualifications (ANC) function under Ministry of Education. ANC acts as National Coordination Point for EQF (European Qualification Framework), Contact Point for ESCO (European Skills and Competence portal), Europass National Center and National Support Service for EPALE (Electronic Platform for Adult Learning in Europe).

- Management of the personal data according to the European and National legislation (GDPR);
- Management of the IT platform (e-learning, admission, student's management systems, electronic documents system etc.)
- Development of the specific automatization systems;
- Support for students, teachers and support personnel in using the ICT technologies

Additionally, West University of Timisoara provide access to the G Suite for Education package from Google and Microsoft 365 A1 license.

It is also provided access to an eLearning platform based on the LMS-Moodle partially customized (e.g. virtual classes, test modules etc.).

4.2.1.3 New development in the context of Covid-19 Pandemic

The Covid-19 pandemic forced the education institutions to adapt to online learning. In Romania, during the state of emergency[5] the whole education system has been virtual. West University of Timisoara exploited this situation as an opportunity and transitioned to eLearning very easily, benefiting also by a strong infrastructure. Thus, students and teachers quickly adapted to virtual education. However, experts interviewed frequently indicated difficulties generated by the lack of digital skills, particularly among teachers, in efficient use of resources and digital instruments for education (e.g. G-suite for Education, Microsoft Education, Learning Management Systems). Therefore, the University has provided trainings and online tutorials to teachers and students and developed a set of regulations to ensure the quality of virtual education.

As a result of mobility restriction, West University of Timisoara implemented for the academic year 2020-2021 a specialized platform for online admission (all admission process was conducted exclusively online) and also an online platform for application to obtain accommodation in student houses.

Additionally, a postgraduate course in the field of Technologies and Digital Resources for Online Training was launched. The program aims to develop digital skills for online learning, being the first of this kind in Romania.

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[5] On 16 March the authorities declared State of Emergency – all schools moved to online. On 14 May the State of Alert replaced the stricter State of Emergency – schools were partially opened. West University of Timisoara decided that all academic activities on the first semester will be conducted online. On 8 November all schools were closed again.

5 Critical points and Gaps in Policy Response

Within the European Union, the European Commission's Digital Economy Society Index for 2018 shows that EU countries face deep digital development gap and therefore „it should invest more in digital and also complete the Digital Single Market as soon as possible to boost Europe's digital performance". Even more, the same disparity is seen on digital skills, „while Nordic countries and the U.K. have populations with notably advanced digital skills, almost half of all Europeans still lack basic technical competences", according to the index.

Main problems and strategic areas accounted in terms of digitalization in Romania are:

- E-government, cybernetic security, cloud computing, open data, big data and social media;
- ICT in education, health, culture and e-inclusion;
- E-commerce, research and development and innovation in ICT;
- Broadband and digital services infrastructure.

Romania continues to register the lowest level of internet use among the EU Member States, which corresponds to the lowest level of at least basic digital skills accounted by the country in the last few years (DESI, 2020). Same counter performances are registered in terms of digital public services, where Romania holds the bottom position in the last three years. Hence, the e-government, cybernetic security, cloud computing, open data, big data and social media direction represents a main problem and strategic area with a decisive impact on long-term socio-economic development. The focus is on online public services, e-Governance platforms, electronic systems, cybernetic infrastructure etc.

In terms of education, the ICT knowledge are considered essential in the teaching-learning process, since the ICT infrastructure can facilitate communication, knowledge transfer, as core elements of a knowledge-based digital society. Romania's national education system must swiftly and appropriately respond to the challenges digitalization poses.

E-commerce, research and development and innovation in ICT are other key directions considered by Romania as fundamentals of digitalization.

Broadband and digital services infrastructure complement previous strategic components and enhance the progress achieved by Romania in this area.

5.1 Low level of digital skills

As entailed previously, in Romania, the low level of digital education persists, Romanians using the internet merely to access the social media networks and for entertainment; moreover, Romania faces a large gap between the rural and urban areas as regards the technological infrastructure of broadband connectivity (only 40 percent coverage in the rural areas). Some studies also attest that in Romania approximatively 74 percent of the people aged 16 to 74 do not have basic digital skills, while only 1 percent of the adults have benefited from continuous (lifelong) professional education/learning [SURSA]. The situation is much more difficult if we compare the 'above basic' digital skills, Romania ranking last in the EU in 2020 and without any progress achieved in this regard in recent years.

Frequently, employers highlight the lack of digital skills among graduates. Even though a discipline in the field of ICT is compulsory from the ISCED 2 level, the skills provided are in many cases to general. The curricula are difficult to adapt to the requirements of the labour market. The Romanian Education System is a centralised and learning is guided by a national curriculum compulsory for all schools of the country.

5.2 Lack of a digital strategy in education

In Romania, at the national level, there still lacks a clearly defined strategy for adapting the educational system to the requirements of the digital age, even though digitalization is present in almost all areas of our lives and the socio-economic activities.

The experts interviewed highlighted the lack of a comprehensive national strategy on digitalization in education as one of the main problems. Additionally, they pointed out the lack of basic digital skills that can enable the use of advanced technologies, particularly by the support employees in universities, but also the lack of advanced digital instruments (e.g. electronic signature). Another major issue is the training of education providers/ educators/ teaching staff to be able to pass on this technological knowledge to pupils/ students so they can acquire at least basic digital skills and a minimum necessary knowledge about the use of information and communication technology.

At the same time, the Romanian national education system continues to face a lack of hardware technology. More specific, in many lower and upper secondary education institutions, especially in the rural areas, there lacks the hardware equipment necessary to implement software programs and where there is hardware technology, it is often outdated, already exceeded by current requirements.

The digital strategy of the Romanian educational system should be based on several key credentials: (i) endowment of all education institutions with modern technological equipment and implementation of the most sought-after software programs on hardware equipment in all education institutions; (ii)

specialization of educators in the science of information and communication technology; (iii) continuous assessment on the level of digital skills acquired by both teachers and learners that can enable the use of advanced technologies; the evaluation of the teaching staff should not be done only on the basis of the digital knowledge accumulated by the teachers, but also on the basis of the results obtained at each evaluation by the students.

5.3 Lack of autonomy of HEIs

Higher education institutions (HEIs) have been permeated by the technological advancement that the digitalisation brings with it and forces institutions to deal with a digital transformation in all dimensions. Applying the approaches of digital transformation to the HEI domain is an emerging field that has aroused interest during the latest years, as they allow us to describe the complex relationships between actors in a technologically supported education domain. Digitalization or Digital transformation (DT) has become a priority for higher education institutions (HEIs) in this second decade of the 21st century, and this is a natural and necessary process for organizations that claim to be leaders of change and be highly competitive in their domain. Digital transformation implies the profound conversion of business activities and organizations, processes, competencies and models, for the maximum transformation of the changes and opportunities of a technology mix and its accelerated impact on society, in a strategic and prioritized way (Gobble, 2018).

Specialists consider that it is important to use tools which satisfy contemporary educational standards and various methods, but first of all, the tools based on digital technology. To innovate the pedagogical methodologies, we must know that innovations in digital teaching are not just technical innovations, but rather academic, curricular, organizational and structural innovations. In this respect, the use of digital educational resources is perceived as enabling new roles for teachers and students, creating flexible and motivating ways of learning, being more autonomous and collaborative.

Lack of autonomy of Higher Education Institutions (HEIs) in terms of digitalization may be a problem and a big challenge these days. It is known that the autonomy of institutions has dominated so far, the processes on how institutions are expected to handle aspects of digitalization and continues to dominate that aspect. Today, big data, digitalization, climate change and socio-economic globalization have challenged the university's central position in research and (higher) education and its privileged position as an autonomous "republic of science". Universities are facing institutional change and instability, which have forced them to re-examine their identity, rules and norms (Mehling and Kolleck, 2019).

6 Good practice identified locally and nationally

6.1 Integrated Educational Register

Integrated Educational Register (REI) is a platform managed by the Ministry of Education. It offers access to the educational route/professional pathway of an individual, by interconnecting the management system from the educational sector with the connected management systems, by a cloud-type solution. REI integrates all modules used in the National Education System: The Integrated Informatics Education System of Romania (SIIIR), The Unique Matriculation Register (RMU) and The Romanian Higher Education Quality Assurance Agency (ARACIS). REI also permits the generation of reports and statistic indicators on enrolled students based on real-time data reported by universities (e.g. by geospatial distribution, specializations, level of study, etc.)

6.2 National Student Enrolment Single Registry

National Student Enrolment Single Registry (RMU) is a component of REI. By RMU, universities can run administrative operations at student level achieving interoperability between existing databases at the pre-university and higher education levels, and facilitating retrieving data from SIIIR (Integrated Information System of Education in Romania) in the RMU.

6.3 Digital platform with open educational resources – EDULIB

This is a work in progress with the deadline in 2022. It is managed by the Agency for Administration of the National Network for Education and Research (ARNIEC). Through this Virtual Library there will be developed/ selected and included open educational resources (OER) that will support teachers and students in education.

6.4 Google Digital Workshop project

The Digital Workshop (Atelierul Digital) was launched in 2016 by Google Romania in collaboration with The University of Bucharest (UB) and Babes Bolyay University from Cluj-Napoca and Polytechnica

Timisoara. In 2017, West University of Timisoara became also host of a Google Digital Workshop. In the first stage, the project aimed to deliver and develop digital skills to students so they could advance in their careers or find a job. Later, Google expanded the program to target software developers and also set up incubators for start-ups.

The workshops for programmers and includes programming classes help students to develop programming knowledge in Java or Android development. The Google Startup Incubator also addresses the students trying to start a business in ICT field.

The Digital Developer Workshop is part of Grow with Google, a global initiative that aims to create opportunities for everyone by offering free courses, resources and advice.

6.5   E-SkillsConnect – Digital Skills Lab

Digital Skills Lab it was set up by the Lucian Blaga University from Sibiu. It is a project which aims development of digital skills among students required on the labour market. Within the digital lab, students can participate in a various workshop getting skills and competencies in ICT field. The students have also the possibility to follow online trainings to obtain Google certifications.

6.6   WeLearn Platform

WeLearn platform was developed within the Minds Hub Timisoara. Minds Hub run under the umbrella of West University of Timisoara. It is a is a complementary educational initiative which has as main objective minimizing the gap between the competences that students get in university and the ones needed on the market. WeLearn platform brings together professionals from corporations and students. The aim is to deliver webinars for students to improve their skills in order to become better prepared before starting the professional career.

6.7   Cloud-Enabled Laboratory

Cloud-Enabled Laboratory was launched in 2018 as a common project between West University of Timisoara and Microsoft. It is an infrastructure that provide access to cloud resources that can be used for teaching and learning process but also for research projects and technological start-ups in the field of ICT.

The laboratory was set up with the goal to help students to adapt to future highly digitalised labour market.

6.8   E-Austria Timisoara Institute

Institute e-Austria Timisoara is a research institute set up in 2002. It is focused on promotion of excellence in scientific research and technological transfer in the field of information technologies.

The institute is a private non-profit research association between three main partners:

- RISC (Research Institute for Symbolic Computation, Linz, Austria);
- WUT (West University of Timisoara Timisoara, Romania);
- UPT (Politehnica University Timisoara, Romania).

The funds for the institute start-up were provided by:

- BMWF (Austrian Ministry of Education, Science, and Culture);
- BMWA (Austrian Ministry of Economy);
- MEC (Romanian Ministry of Education and Research).

The institute is mainly engaged in joint R&D e-technology projects between the computer science departments of the universities in Timisoara, the institute, and the e-technologies industry. The main activity of the Institute e-Austria Timisoara is based on direct technology-transfer projects with companies from Europe. These projects allow companies active in the field of e-technologies to benefits of the high scientific expertise of the institute in order to improve their production process, the quality of their products (including more efficient testing), and in general in order to increase their competitivity on the market by using the most advanced information technologies.

The institute offers:

- highly skilled scientists and e-technology specialists, combining the expertise of the faculty from RISC, the West University of Timisoara, and the Politechnica University;
- access to the expertise in successful achievement of e-technology projects from these universities;
- cooperation with companies with high expertise from Europe;
- access to European funds for RTD.

7 Recommendations for action

In order to adapt to the digital age, it is necessary to rethink the educational policies, investments in human capital being probably more important today than ever. In many cases, the universities today prepares students for jobs in the past and at most in the present and less for the future.

The young people who are on the school benches today, those who guide them as well as those who make up their school curricula have very few ideas about what the labor market will look like and what kind of skills / competencies will be required at the time of graduation. In an interconnected world, with access to information 24/7, where learning new things or enrolling in various online courses / universities is just a click away (e.g. MOOCs - Massive Open Online Courses: Khan Academy, Stanfordonline etc), digital technologies are already making their presence felt in the educational environment, giving rise to new learning concepts, for example Higher Education 4.0 (Jeschke and Heinze, 2014).

At the same time, a priority is to find solutions for persons who already have a job, but rather face or will face problems with the changes brought by digitalization, automation, robotics. The development of lifelong learning in the first place, as well as adaptability, flexibility, critical thinking, creativity, seem to be part of the solutions of the future. Employers will also play an important role in supporting / preparing employees to be able to adapt to the new requirements and changes that will occur in the workplace, as they must rethink their human resource management strategy in order to remain competitive and have the opportunity to a sustainable development in the context of digitalisation.

The experts interviewed outlined the following recommendations for action:

- Designing an online national education system (national platforms easy to use and safe, integrated with data administration systems and with those for students' assessment);
- Institutional development projects through digitalization;
- Training programmes dedicated for educators/teachers to use the online teaching applications/tools;
- Support for deploying adequate pedagogical resources for online teaching;
- Courses particularly designed for teachers to use advanced technologies;
- Financial support for vulnerable students (in order to acquire laptop, apps etc.);
- Unitary/standardised platforms for online education;
- Adjusting the curricula at all education levels (primary, lower-secondary, upper-secondary) to the specific of digital technologies;
- Setting specific quality targets and requirements for digital (online) activities;
- Creating and financially supporting a "digitalization" program of higher education institutions (Digital University), through which there can be allocated resources necessary to implement integrated informatics systems;

- Major investment in servers and upgraded internal networks, as well as in advanced training for specialized employees;
- Changing the legislation for online education.

One of the main focus should be on the updating curricula to train the students so that they have compatible digital skills with those required by labour market. In order for education and training to respond and, even more, to anticipate the requirements (skills of the future) that have emerged as a result of the implementation of new technologies related to digitalisation from the labor market perspectives, it is necessary to develop new models to estimate the impact of these technologies on jobs for all sectors of country economy.

Taking into account the challenges that digital technologies can bring to the labor market, McKinsey Global Institute draws a series of possible solutions with positive impact (Manyika, 2017) to overcome them:

- Development of education systems and learning for a changed/different job;
- Determining how the private sector can conduct training;
- Creating incentives for private sector investment to treat human capital like any other capital;
- Exploring public-private partnerships to stimulate investment in infrastructure facilitation;
- Rethinking income (for example, basic universal income);
- Rethinking support for the transition and safety of affected workers;
- Adopt solutions compatible with technologies that can be used in the labor market to improve correlation and access and reduce skills gaps;
- Focus on job creation;
- Innovating the way people work with cars
- Control the benefits of technological productivity to create growth, surpluses and labor demand, which configure space for creative solutions and ultimately benefit from it all.

The wave of digitalisation is so strong that change is inevitable, including in education. Thus, Education 4.0 appeared as a conceptual response, a ubiquitous concept in current educational systems, in which people and technology are brought together to create new learning opportunities (Hussin, 2018). The ubiquity of digital devices and applications requires educators to develop their digital competence. A framework and tool also built to support educators at all levels of education at European level is Digital Competence of Educators (Redeckers, 2017). The European Framework for the Digital Competence of Educators (DigCompEdu) responds to the growing awareness of many European countries that educators need a profession-specific set of digital competences in order to take advantage of the potential of digital technologies to improve and innovate education.

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9   Appendices

9.1   Appendix 1: Expert interviews

| Name of organisation	Type of organisation	Expert's position	Interview date	Mode of interview (telephone, mail, etc.)
West University of Timisoara	Higher Education Institution	Professor / administrative responsibilities	14 September 18 September	Informal conversations / emails
West University of Timisoara	Higher Education Institution	Professor / administrative responsibilities	21 September	Email exchanges / video meeting
West University of Timisoara	Higher Education Institution	Professor	21 September	Email exchanges / video meeting
Bucharest University of Economic Studies	Higher Education Institution	Professor / administrative responsibilities	08 September	Email exchanges / Phone call
Alexandru Ioan Cuza University Iasi	Higher Education Institution	Professor / administrative responsibilities	09 September	Email exchanges / Phone call
Babes-Bolyai University Cluj-Napoca	Higher Education Institution	Professor / administrative responsibilities	28 September	Email exchanges / Phone call

| Name of the Programme	Digital Skills and Knowledge
MSc in Artificial Intelligence and Distributed Computing	Modelling designing and implementing systems based on artificial intelligence methods and parallel and distributed approaches, performing cloud computing and high-performance computing; designing multi-agent systems; configuring machine learning, deep learning models, configuring network security models and architectures
MSc in Big Data – Data Science, Analytics and Technologies	Statistical analysis of data, design implementing and using data mining algorithms, in using technologies for big data processing and in implementing scalable applications, Big Data Technologies, Data Warehouses, Cloud Computing, Data Mining, Machine Learning, Data Analysis and Programming in R, designing and implementing Probabilistic Models for Data Science,
MSc in Information Systems for Businesses	Business intelligence, advanced methods and techniques for software engineering, advanced methods and techniques to approach and investigate informatics systems, advanced use of supportive informatics applications to develop information systems developing websites and online businesses, Web performance optimization
MSc in Cyber Security	Architectures and models of network security, ensuring the quality and reliability of software systems, developing robust applications, processing large amount of data, developing multi-agent systems, data mining, applying methods and techniques based on XML, security and share of public interest data
PgD in Blockchain Entrepreneurship	Cryptocurrencies programming and transactions, the blockchain technology, programming applications on various blockchain platforms, blockchain entreprenurship and financial skills
PgD in Digital Skills in Services	Computer systems, operating systems and the Internet by the employees from various organizations in the ICT sector, adequate use of office supplies software products to solve specific problems
PgD in Technologies and Digital Resources for Online Training	Use of resources and digital instruments, communication and collaboration based on digital technologies, problem solving in terms of digital technology, G-suite for Education, Microsoft Teams for Education, (Learning Management System - LMS) Moodle

9.3   Appendix 3: Digital Economy and Society Index 2020: Romania

Digital Economy and Society Index

Digital Economy and Society Index: 1 Connectivity

Digital Economy and Society Index: 2 Human Capital
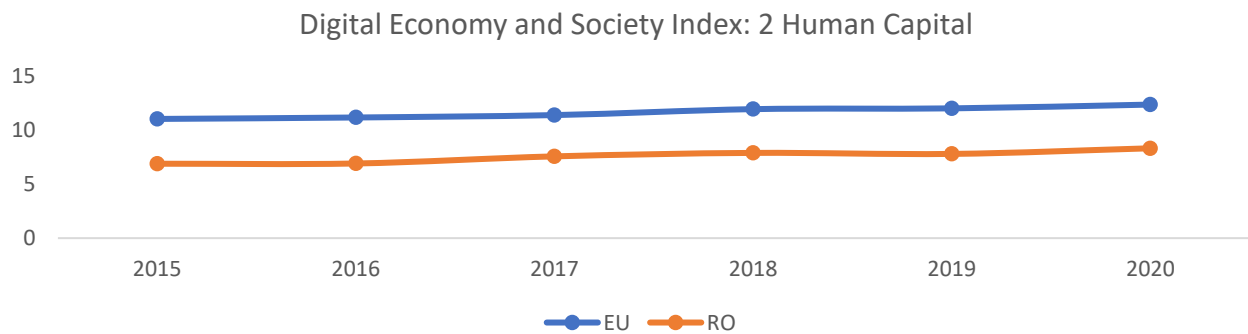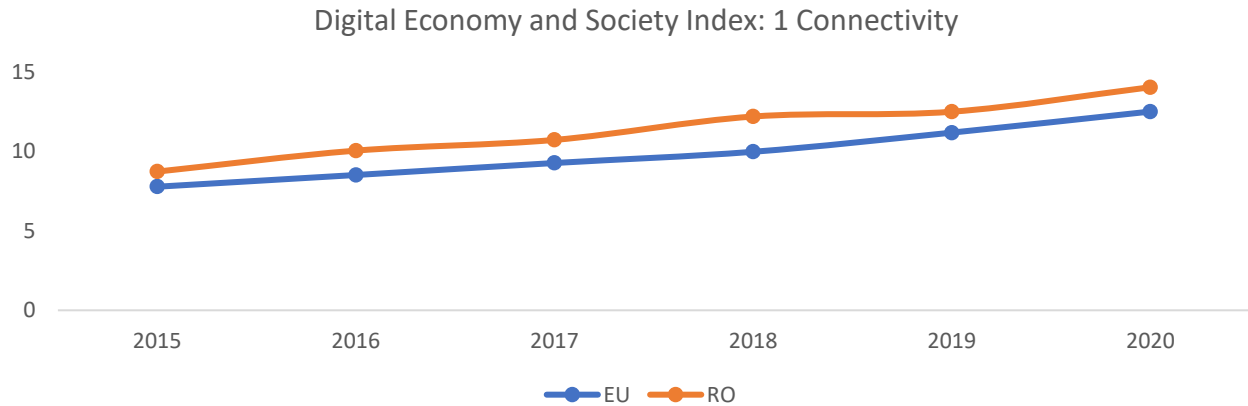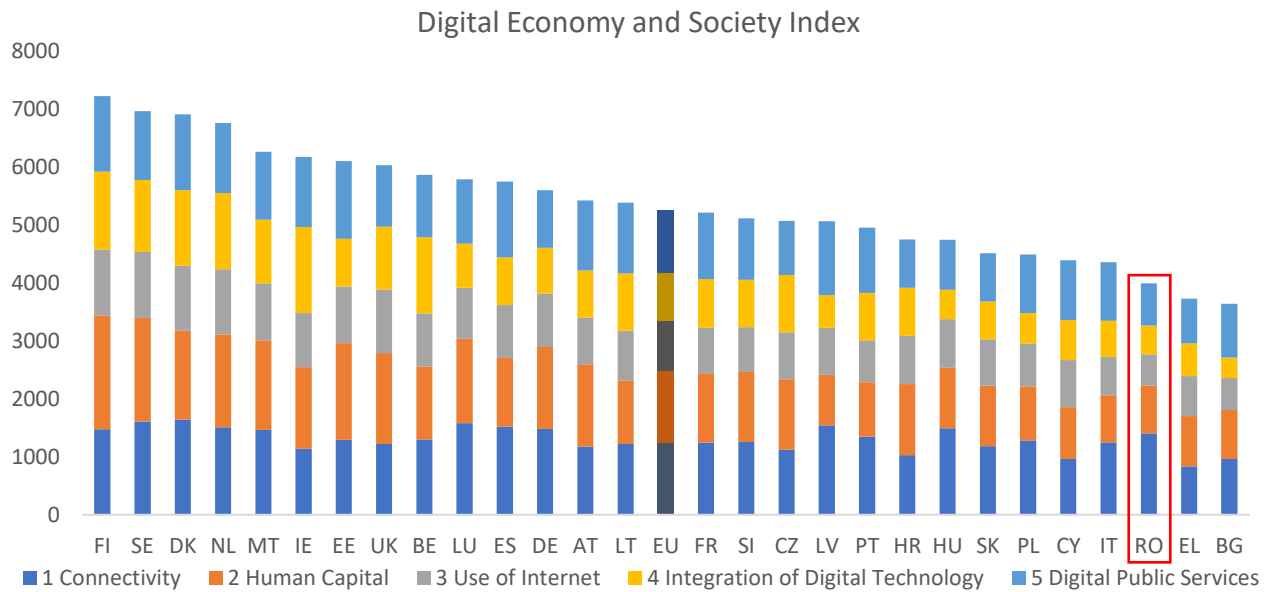
Digital Economy and Society Index: 3 Use of Internet
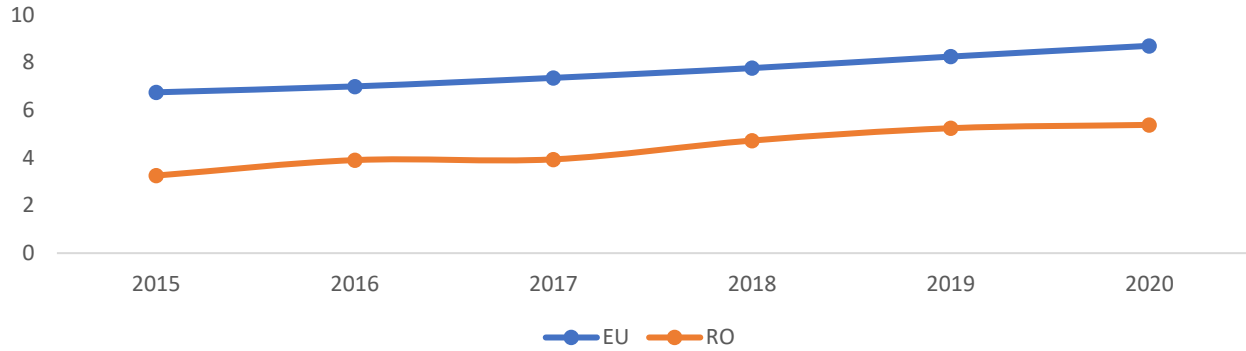
Digital Economy and Society Index: 4 Integration of Digital Technology
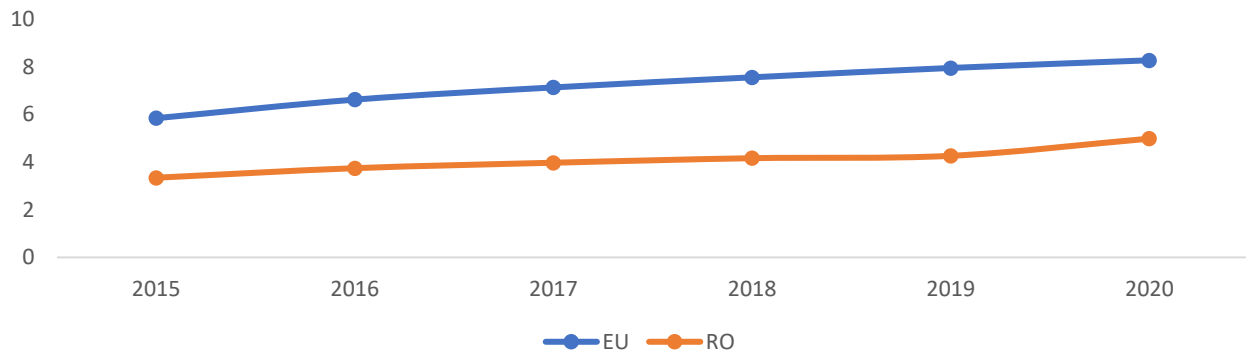
Digital Economy and Society Index: 5 Digital Public Services